



VLSM and CIDR

Routing Protocols and Concepts – Chapter 6



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Objectives

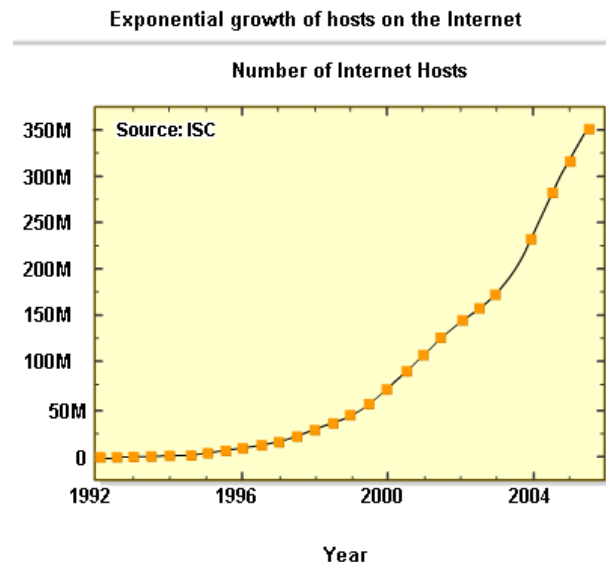
- Compare and contrast classful and classless IP addressing.
- Review VLSM and explain the benefits of classless IP addressing.
- Describe the role of the Classless Inter-Domain Routing (CIDR) standard in making efficient use of scarce IPv4 addresses.

Introduction

- Prior to 1981, IP addresses used only the first 8 bits to specify the network portion of the address
- In 1981, RFC 791 modified the IPv4 32-bit address to allow for three different classes
- IP address space was depleting rapidly
 - The Internet Engineering Task Force (IETF) introduced Classless Inter-Domain Routing (CIDR)
 - CIDR uses Variable Length Subnet Masking (VLSM) to help conserve address space
 - VLSM is simply subnetting a subnet

Classful and Classless IP Addressing

- Classful IP addressing
- As of January 2007, there are over 433 million hosts on internet
- Initiatives to conserve IPv4 address space include:
 - VLSM & CIDR notation (1993, RFC 1519)
 - Network Address Translation (1994, RFC 1631)
 - Private Addressing (1996, RFC 1918)



Classful and Classless IP Addressing

- The High Order Bits
 - These are the leftmost bits in a 32 bit address

Class	High Order Bits	Start	End
Class A	0	0.0.0.0	127.255.255.255
Class B	10	128.0.0.0	191.255.255.255
Class C	110	192.0.0.0	223.255.255.255
Multicast	1110	224.0.0.0	239.255.255.255
Experimental	1111	240.0.0.0	255.255.255.255

Classful and Classless IP Addressing

- Classes of IP addresses are identified by the decimal number of the 1st octet
 - **Class A** address begin with a **0** bit
 - Range of class A addresses = 0.0.0.0 to 127.255.255.255
 - **Class B** address begin with a **1** bit and a **0** bit
 - Range of class B addresses = 128.0.0.0 to 191.255.255.255
 - **Class C** addresses begin with **two 1** bits & a **0** bit
 - Range of class C addresses = 192.0.0.0 to 223.255.255.255

Classful and Classless IP Addressing

- The IPv4 Classful Addressing Structure (RFC 790)

- An IP address has 2 parts:

- The **network** portion

- Found on the **left** side of an IP address

- The **host** portion

- Found on the **right** side of an IP address

Classful and Classless IP Addressing

Subnet Mask based on Class

	1st Octet	2nd Octet	3rd Octet	4th Octet	<u>Subnet Mask</u>
Class A	Network	Host	Host	Host	255.0.0.0 or /8
Class B	Network	Network	Host	Host	255.255.0.0 or /16
Class C	Network	Network	Network	Host	255.255.255.0 or /24

Number of Networks and Hosts per Network for Each Class

Address class	First Octet Range	Number of Possible Networks	Number of Host per Networks
Class A	0 to 127	128 (2 are reserved)	16,777,214
Class B	128 to 191	16,348	65,534
Class C	192 to 223	2,097,152	254

Classful and Classless IP Addressing

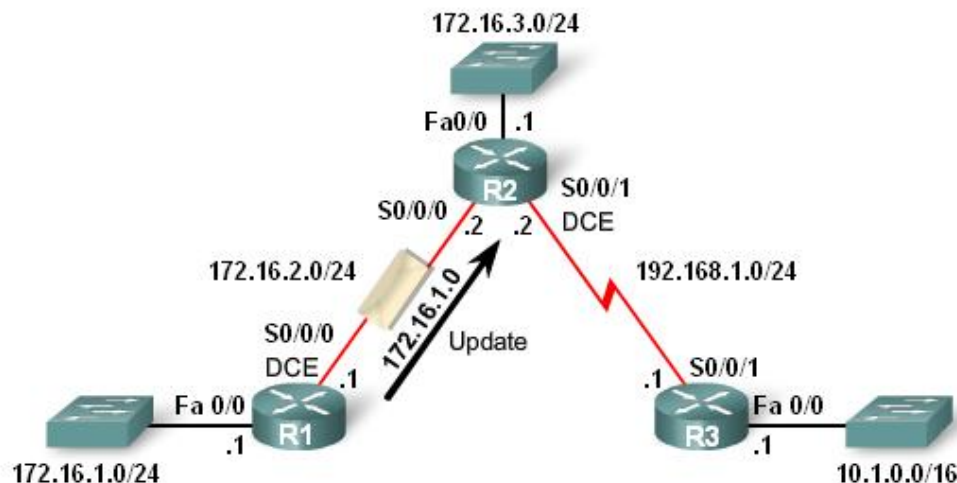
- **Purpose of a subnet mask**
 - It is used to determine the network portion of an IP address

Classful and Classless IP Addressing

- Classful Routing Updates
 - Recall that **classful routing protocols** (i.e. RIPv1) **do not send subnet masks** in their routing updates
 - The reason is that the Subnet mask is directly related to the network address

Classful routing updates

R3 applies the classful/16 mask to the 172.16.0.0 routing update from R2

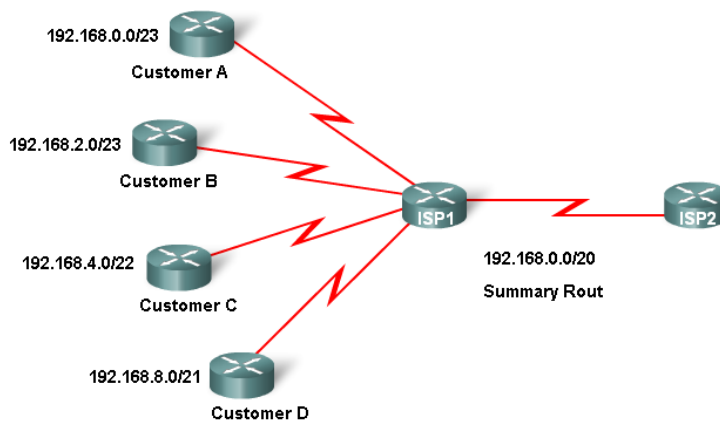


Classful and Classless IP Addressing

- Classless Inter-domain Routing (CIDR – RFC 1517)
 - Advantage of CIDR :
 - More efficient use of IPv4 address space
 - Route summarization
 - Requires subnet mask to be included in routing update because address class is meaningless
 - Recall purpose of a subnet mask:
 - To determine the network and host portion of an IP address

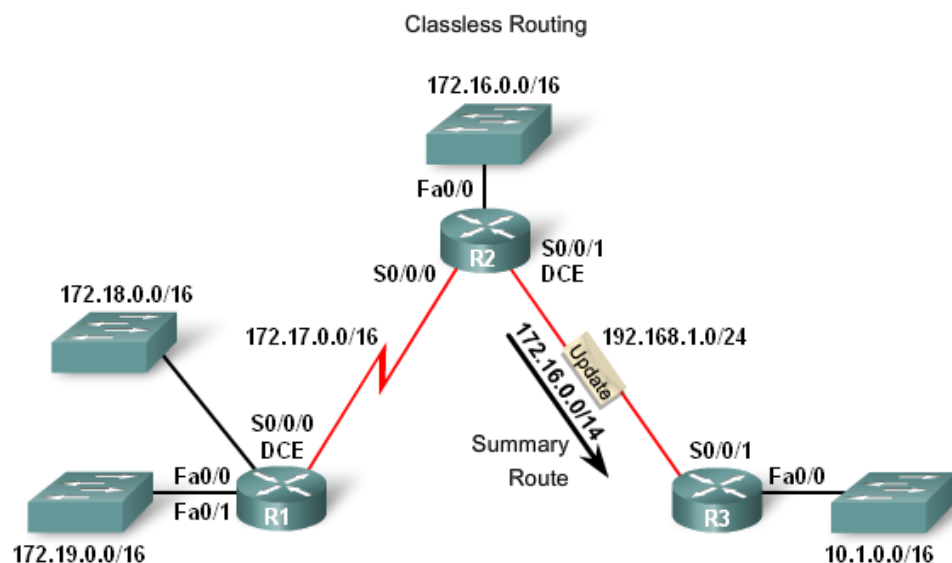
Classful and Classless IP Addressing

- Classless IP Addressing
- CIDR & Route Summarization
 - Variable Length Subnet Masking (VLSM)
 - Allows a subnet to be further sub-netted according to individual needs
 - Prefix Aggregation a.k.a. Route Summarization
 - CIDR allows for routes to be summarized as a single route



Classful and Classless IP Addressing

- Classless Routing Protocol
- Characteristics of classless routing protocols:
 - Routing updates include the subnet mask
 - Supports VLSM
 - Supports Route Summarization



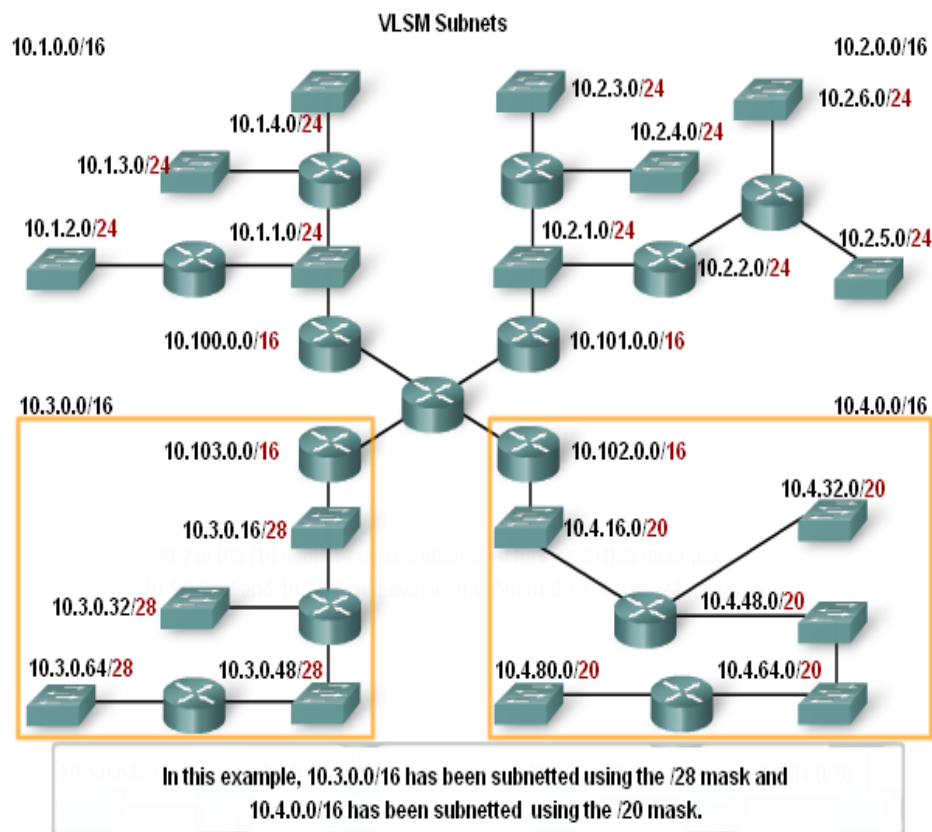
Classful and Classless IP Addressing

- Classless Routing Protocol

Routing Protocol	Routing updates Include subnet Mask	Supports VLSM	Ability to send Supernet routes
Classful	No	No	No
Classless	Yes	Yes	Yes

VLSM

- Classful routing
 - Only allows for one subnet mask for all networks
- VLSM & Classless routing
 - This is the process of subnetting a subnet
 - More than one subnet mask can be used
 - More efficient use of IP addresses as compared to classful IP addressing

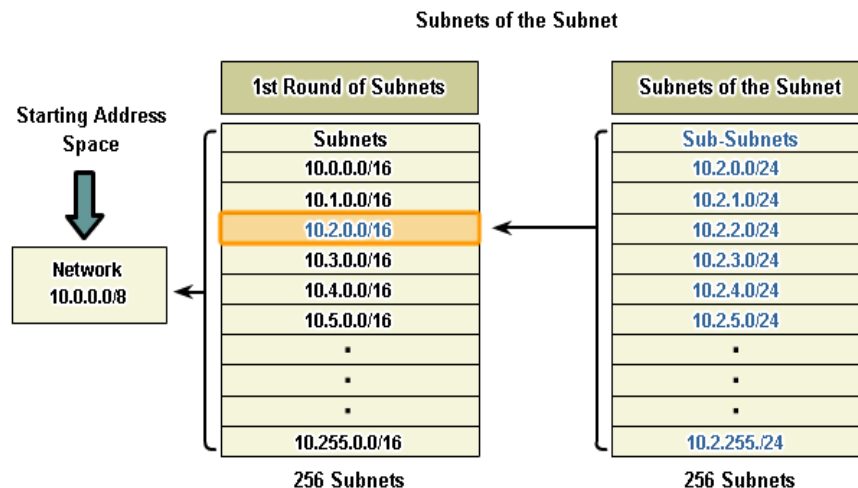
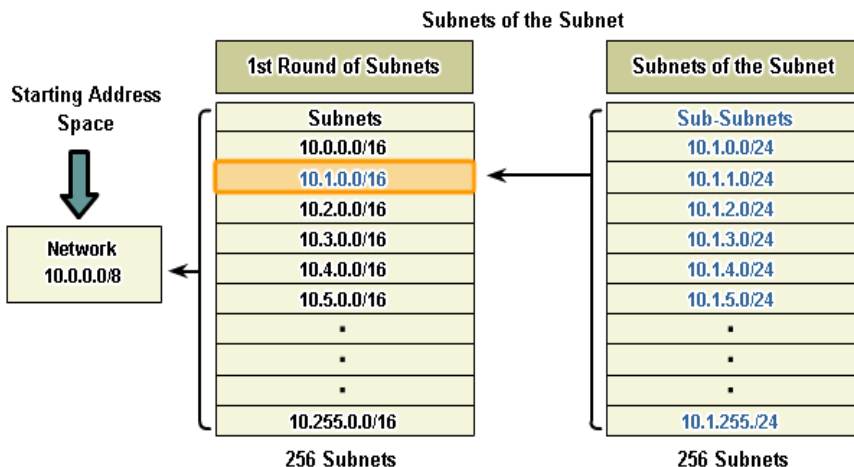


VLSM

- **VLSM** – the process of **sub-netting a subnet** to fit your needs

- **Example:**

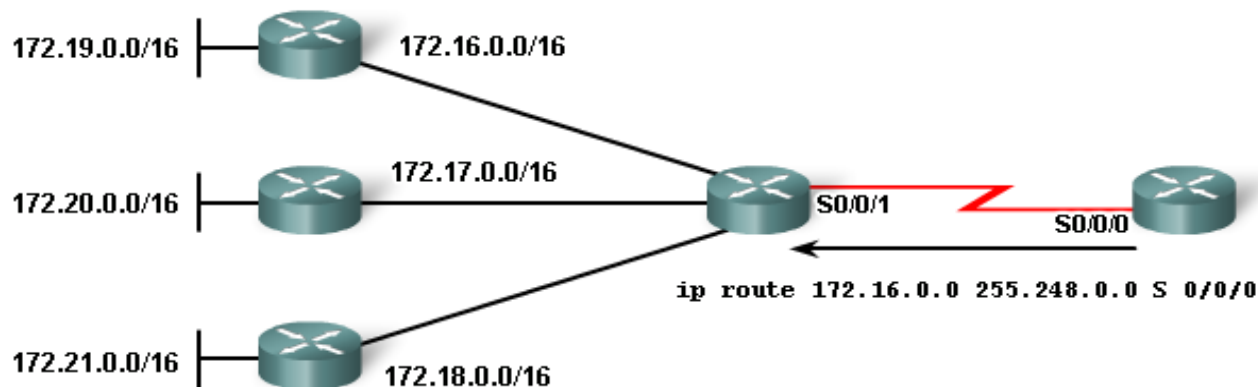
- Subnet 10.1.0.0/**16**, 8 more bits are borrowed again, to create 256 subnets with a **/24** mask.
- Mask allows for 254 host addresses per subnet
- Subnets range from: 10.1.0.0 / 24 to 10.1.255.0 / 24



Classless Inter-Domain Routing (CIDR)

- Route summarization done by CIDR
 - Routes are summarized with masks that are **less than** that of the **default classful mask**
 - Example:
 - 172.16.0.0 / **13** is the **summarized route** for the 172.16.0.0 / **16** to 172.23.0.0 / **16** classful networks

Route summarization



Classless Inter-Domain Routing (CIDR)

- Steps to calculate a route summary
 - List networks in binary format
 - Count number of left most matching bits to determine summary route's mask
 - Copy the matching bits and add zero bits to determine the summarized network address

Calculating a Route Summary

Step 1: List networks in binary format.

172.20.0.0	10101100 . 00010100 . 00000000 . 00000000
172.21.0.0	10101100 . 00010101 . 00000000 . 00000000
172.22.0.0	10101100 . 00010110 . 00000000 . 00000000
172.23.0.0	10101100 . 00010111 . 00000000 . 00000000

Step 2: Count the number of left-most matching bits to determine the mask.
14 matching bits, /14 or 255.252.0.0

Step 3: Copy the matching bits and add zero bits to determine the network address.

172.20.0.0	10101100 . 00010100 . 00000000 . 00000000
	<div style="display: inline-block; width: 150px; border-top: 1px solid orange; margin-top: 5px;"></div> <div style="display: inline-block; width: 250px; border-top: 1px solid orange; margin-top: 5px;"></div>
	<div style="display: inline-block; width: 150px; text-align: center;">Copy</div> <div style="display: inline-block; width: 250px; text-align: center;">Add zero bits</div>

Summary

- Classful IP addressing
 - IPv4 addresses have 2 parts:
 - Network portion found on left side of an IP address
 - Host portion found on right side of an IP address
 - Class A, B, & C addresses were designed to provide IP addresses for different sized organizations
 - The class of an IP address is determined by the decimal value found in the 1st octet
 - IP addresses are running out so the use of Classless Inter Domain Routing (CIDR) and Variable Length Subnet Mask (VLSM) are used to try and conserve address space

Summary

- Classful Routing Updates
 - Subnet masks are not sent in routing updates
- Classless IP addressing
 - Benefit of classless IP addressing
 - Can create additional network addresses using a subnet mask that fits your needs
 - Uses Classless Interdomain Routing (CIDR)

Summary

- CIDR
 - Uses IP addresses more efficiently through use of VLSM
 - VLSM is the process of subnetting a subnet
 - Allows for route summarization
 - Route summarization is representing multiple contiguous routes with a single route
- Classless Routing Updates
 - Subnet masks are included in updates

